Section 10. Anomaly Analysis Subsystem

10.1 Introduction

This section provides an overview of the Anomaly Analysis Subsystem (AAS) software design. The relationship between AAS and other LPGS subsystems is presented, along with a discussion of the assumptions, constraints, and considerations used in the design process.

10.2 Design Overview

The AAS provides the tools required by the AAS analyst to investigate anomalies or problems generated during LPGS production processing. The AAS tools provide capabilities for viewing production work orders and associated L0R images and data files. Visualization of processing reports and interim image processing files is also supported. The AAS analyst is also provided with tools to generate new work orders for anomaly analysis. In addition, file editing and report generation capabilities are included.

10.2.1 Subsystem Software Overview

The purpose of this subsection is to review the functionality and solution strategy for the LPGS AAS Subsystem software.

10.2.1.1 Functionality

Figure 10–1 shows the AAS context diagram. AAS work is initiated by the analyst, through the AAS analyst user interface (AAUI) when a Problem Report is received from the ECS or when the quality checking of a L1 product fails. The purpose of AAS is to diagnose and , if possible, resolve production related anomalies. Anomalies that are science problems are documented by AAS in an anomaly report which is sent to both the ECS and the DHF.

Internal anomaly requests are generated by LPGS Quality Analysis Subsystem (QAS) when an image product fails to pass either automated or visual quality control procedures. These anomaly requests are sent to LPGS PCS and PCS notifies AAS (through database tables) that there is an anomaly. AAS generates reprocessing work orders in order to diagnose and possibly correct the anomaly. Also, Problem Reports are received concerning L1 products that have been sent out to the customer via ECS.

The AAS is staffed and controlled by a skilled analyst with a strong background in remote sensing image analysis and production image processing. The AAS analyst will work in a very interactive manner. The AAS analyst will have the tools to perform a variety of functions (e.g., generate work orders, view images and data files, generate reports). The AAS analyst is modeled as an external entity on the AAS context diagram.

10.2.1.2 Solution Strategy

The software solution strategy involves reuse of the IAS E&A COTS solution (customized for AAS). The AAS software consists of an integrated set of COTS software packages: ENVI,

IDL, Oracle, and FrameMaker combined with supplementary application software. ENVI provides the GUI for the AAS analyst, as well as much of the required data viewing and production data monitoring capabilities. ENVI provides both the viewing capability for displaying remote sensing images as well as access to Oracle forms for AAS work order submission and other interfaces with the database. The AAS software solution represents reuse on two levels. First, extensive use is made of COTS toolkits. Second, the AAS solution is patterned after the Landsat 7 IAS E&A Subsystem. LPGS AAS and IAS E&A have similar requirements for interactive analyst-directed image processing and data viewing.

10.2.2 Design Considerations

This section describes the design considerations used while developing the preliminary design for the LPGS AAS Subsystem.

10.2.2.1 Assumptions

It is assumed that Problem Reports (i.e., anomalies reported postproduction L1 products that have been received by the customer) will be received from the DAAC Manager via hardcopy or
E-mail. Also, when an anomaly from a Problem Report is resolved by generating a new L1 product, the updated product is saved and a Problem Report response is forwarded to the DAAC Manager.

It is also assumed that AAS will resolve production-related problems only. Scientific problems will be filtered out and forwarded to the DHF via the Anomaly Report.

10.2.2.2 Open Issues

There are several open issues which may influence the design of AAS. The following open issues have been identified:

1. Interface between AAS and ECS relating to the ECS generated Problem Reports,
2. The LPGS handling of image processing datafiles associated with Anomaly Reports
3. ECS User Services resolution of problems relating to errors in specifying user options.

Each of these open issues are discussed below:

There has been a dialogue between the LPGS systems engineers and EDC regarding the nature of the interface between ECS and LPGS AAS for delivery of Problem Reports. While still under discussion, the interface may not be fully automated. Less automated options include transmitting Problem_Reports by a simple E-mail message or even delivery of hardcopy Problem Reports. Either of these approaches would require that the AAS analyst enter the Problem Request information into the Anomaly Request database to queue it with the internal anomaly requests.

The AAS analyst sends an Anomaly Report to both EDC DAAC Management and the DHF when the AAS analyst has not been able to resolve an anomaly and generate a quality image product. If the problem is a science problem, the AAS analyst’s responsibility is to document

it in the Anomaly Report and forward it to the two previously mentioned external entities. There

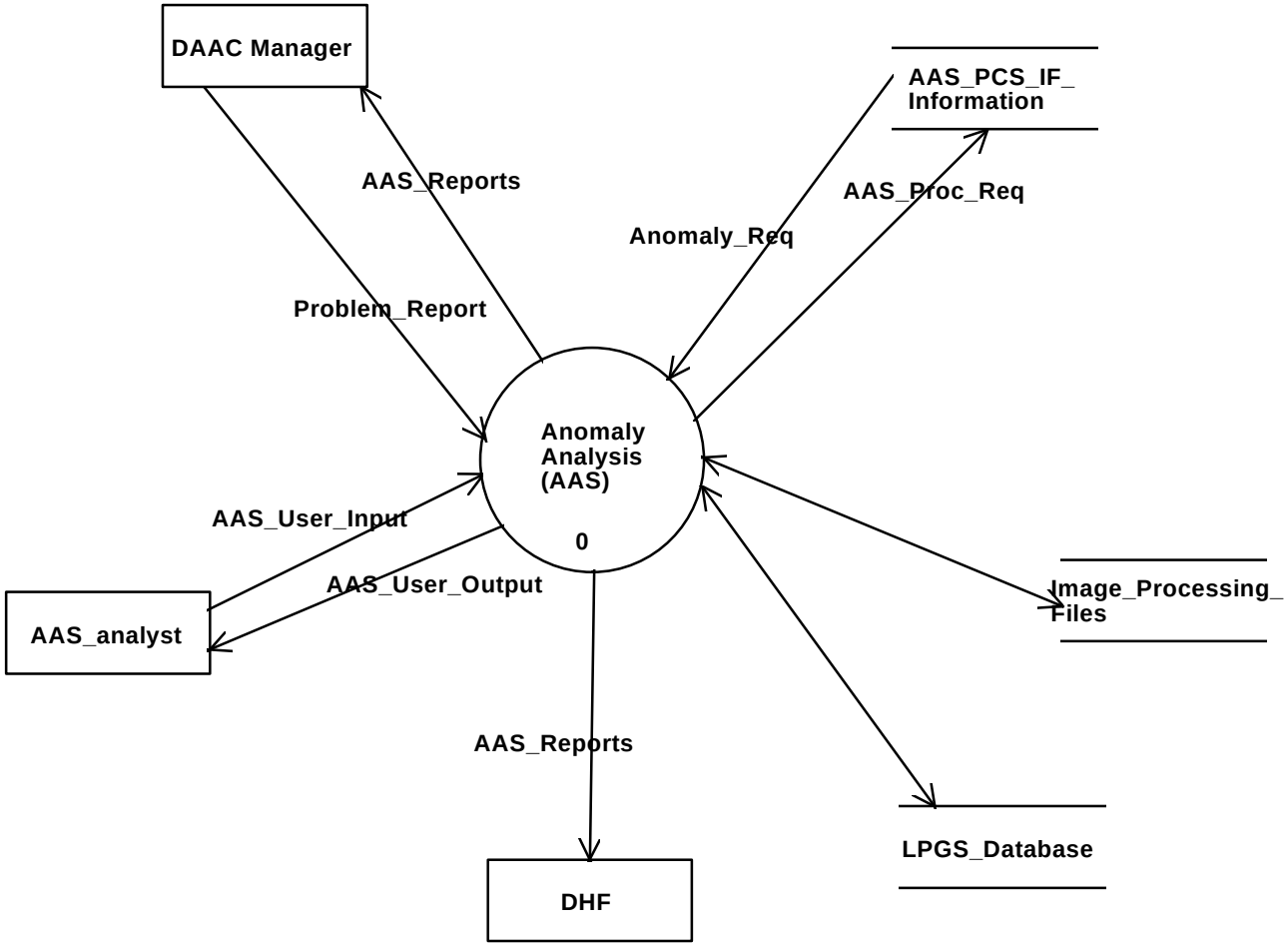

Figure 10–1. AAS Context Diagram

have been requests that the LPGS AAS identify the location of all image processing and other files relating to an anomalous work order documented in an Anomaly Report. This data access would allow other Landsat 7 system entities to further investigate the anomaly. The LPGS AAS operational plan to retain the Anomaly Report related data is to write this data to tape and provide the tape location in the Anomaly Report.

Most of the demand for Landsat data reprocessing at EOSAT is the result of errors in specifying user options. In some cases the error is the result of data entry mistakes made by user services personnel. In other cases the specification error is made by the user. The open issue relating to AAS is whether user option specification errors which result in reprocessing are resolved in ECS User Services or forwarded to AAS in the form of Problem Reports. The LPGS systems engineers expect that user option specification errors will be resolved by ECS User Services. Thus, errors of this type will result in ECS User Services issuing a new L1Product Generation Request with correct specification of user options. This type of reprocessing would be transparent to LPGS (i.e., it would look to LPGS like any other request) and would not impact AAS operations in any way. Wider discussion of this issue is needed to confirm that LPGS expectations are correct.

10.2.2.3 Operational Support

The AAS Subsystem software performs the following operations:

- Maintaining status and history of anomalies
- ASCII and image file display
- Formatted dumps and hardcopy outputs of images
- Generation of diagnostic and reprocessing work orders (see Section 10.3.1.2 for descriptions)
- Controlling diagnostic work order runs
- Access to the results of custom LPGS production applications for radiometric and geometric processing and evaluation
- Report generation
- Screen display of reports

10.2.2.4 Software Reuse Strategy

LPGS AAS is designed to minimize investments in custom software development. The primary functionality needed for AAS will be provided through COTS software products, which are open and can be customized to support AAS specific applications. As mentioned previously, these COTS products include ENVI, IDL, Oracle and FrameMaker. These products will also be used to support the IAS E&A subsystem. There is potential for some reuse of IAS E&A applications or at least an ability to take advantage of developers with experience in customizing these products for IAS E&A.

The AAS analyst uses the results of radiometric and geometric processing performed by the PRS and GPS subsystems. PRS and GPS contain alternate production procedures that allow the AAS analyst to set more flags to stop processing at discrete points to permit viewing of the results. The image processing support needed by the AAS analyst to diagnose anomalies is provided by PRS and GPS. As a result of this reuse of PRS and GPS, no additional image processing routines other than image viewing provided by ENVI are needed to support AAS.

10.3 AAS Subsystem Design

10.3.1 Design Methodology

The methodology for capturing the design of the AAS Subsystem varies in significant ways from the standard methodology for development of custom systems primarily because most AAS capabilities are initiated by the AAS analyst via the AAUI. The functions and data flow of AAS is presented in the AAS DFDs. Many of these functions will be implemented through COTS products. A structure chart and associated module specifications or M-Specs is given to describe the customized application software that will be developed to supplement the COTS products.

10.3.2 AAS Functionality Overview

This section describes the various functions of AAS as shown in the data flow diagrams. These DFDs are shown in Figures 10–2 through 10–5. The following AAS functions are modeled in these DFDs: 1. Manage Problem Requests, 2. Perform Anomaly Runs, 3. Retrieve LPGS Data, 4. Generate Reports, and 5. Transmit Anomalies.

10.3.2.1 Manage Problem Requests

DFD 1.0 shows this function (Figure 10–3). Anomalies are tracked in the Anomaly Status Table that resides in the database. This table contains information about all of the anomalies that are currently in the system, originating either internally or as Problem Reports from the DAAC Manager. For internal problems, when a problem has been detected in the L1 product, either from software checks or from the visual inspection of the L1R or L1G image, PCS enters the anomaly into the Anomaly Status Table. For Problem Reports from the ECS, since, there is no current plan for an electronic interface, the AAS analyst enters the anomaly into the system through the AUI and the anomaly is entered into the Anomaly Status Table. The analyst can bring up a display of the Anomaly Status Table to view a list of all current anomalies and information about each anomaly.

If a solution is found, and, through reprocessing, the anomaly is corrected, the analyst can approve the L1 product for transmission to the ECS. This is done by updating the status in the Anomaly Status Table. PCS finds this status and initiates the process of packaging and transmitting the corrected L1 product.

When an anomaly has either been resolved or sent to the ECS and DHF in an Anomaly Report, the anomaly is closed out. The anomaly is deleted from the Anomaly Status Table and information about the anomaly is written to the Anomaly History Table. This table contains

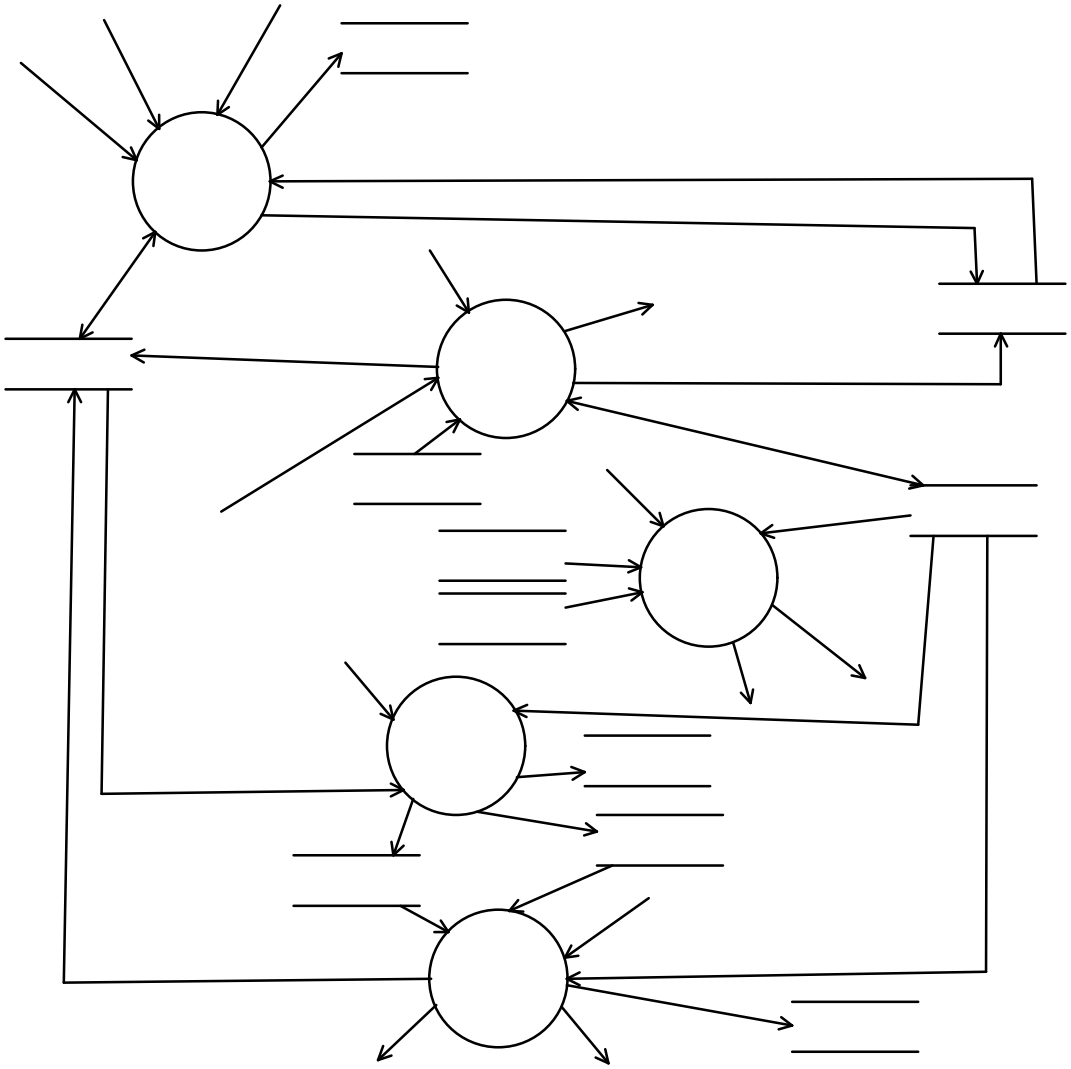

Figure 10–2. AAS Level 0 Data Flow Diagram

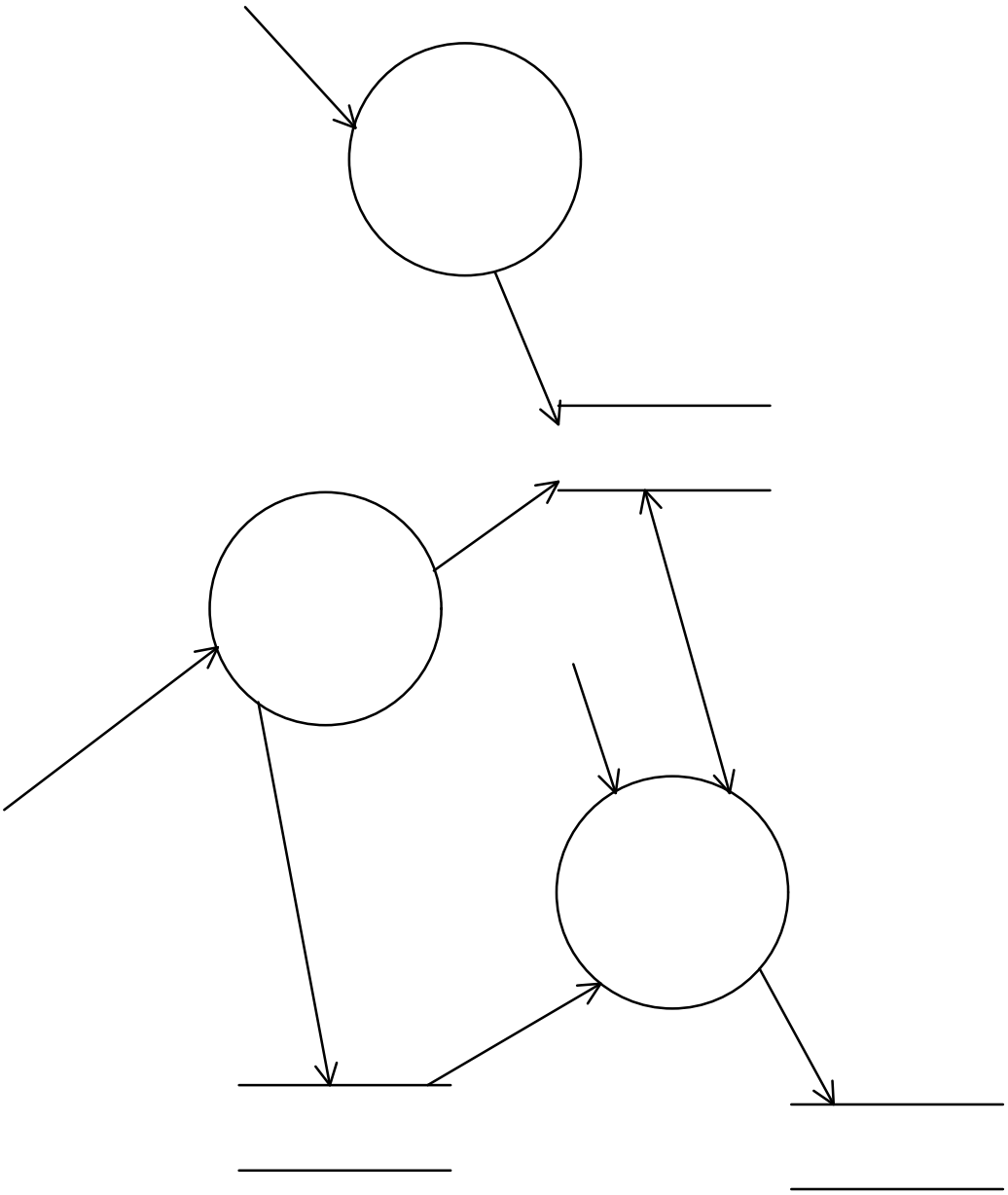

Figure 10–3. AAS DFD 1.0—Manage Problem Requests

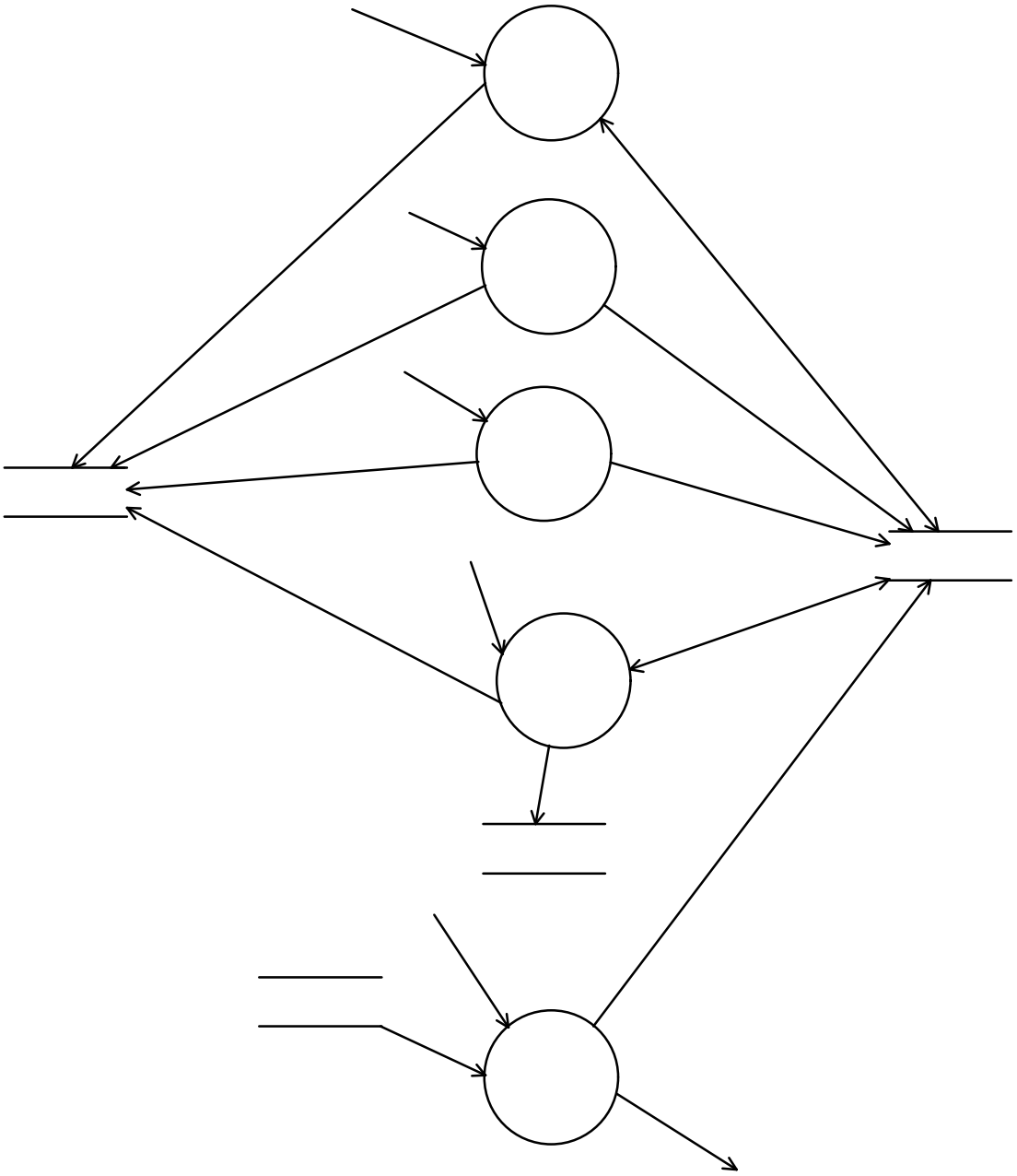

Figure 10–4. AAS DFD 2.0—Perform Anomaly Runs

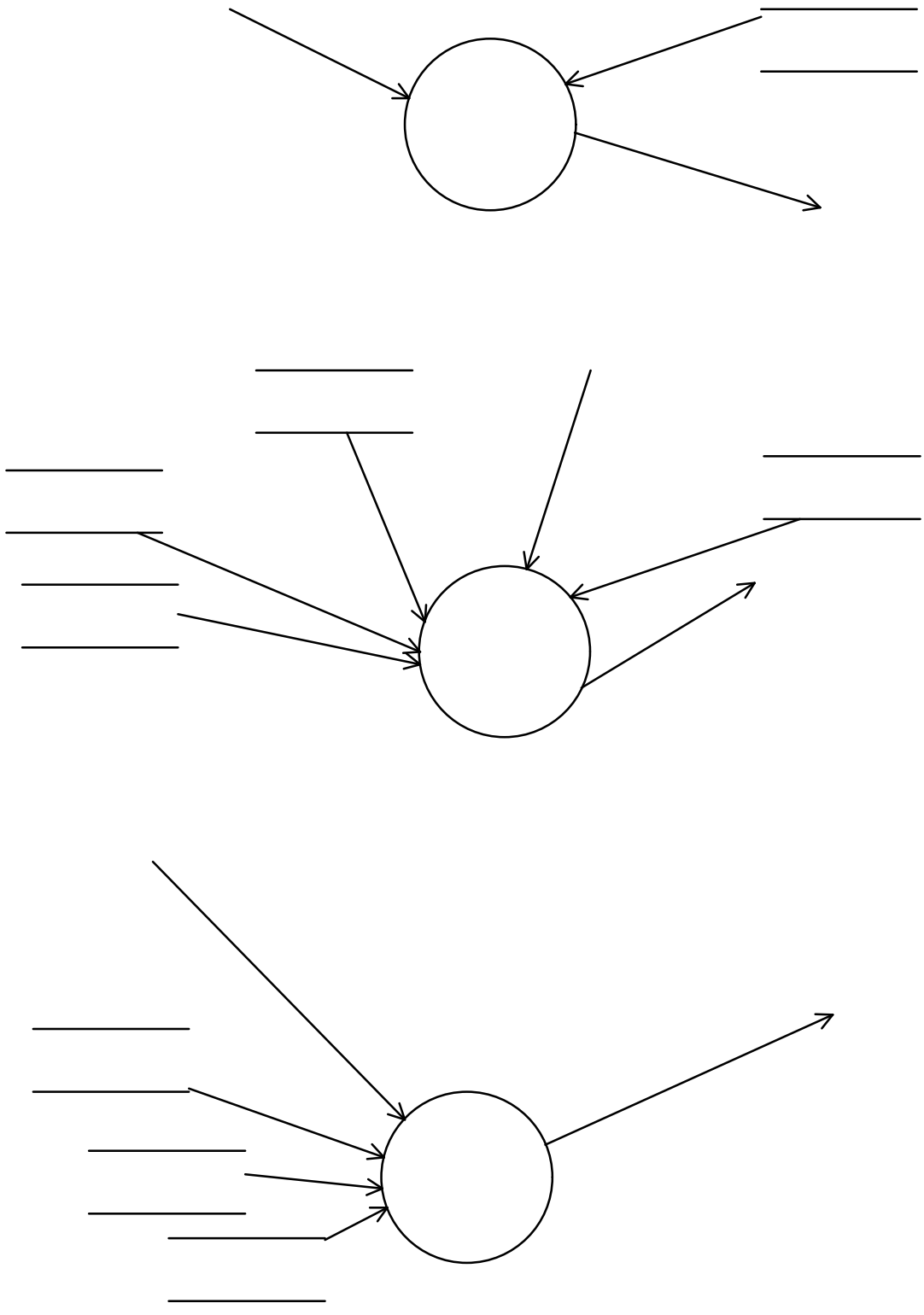

Figure 10–5. AAS DFD 3.0—Retrieve LPGS Data

historical information on anomalies that were resolved and also those that were included in the Anomaly Reports to the DHF. This data store proves useful in diagnosing anomalies because the analyst can compare new anomalies with anomalies that previously occurred.

10.3.2.2 Perform Anomaly Runs

DFD 2.0 shows this function (Figure 10–4). The analyst, through the analyst user interface, will be able to generate work orders in order to analyze and resolve an anomaly. There are three categories of work orders that can be generated.

The first, a diagnostic work order, is generated from the original work order, with the same user options, and contains additional halts to facilitate diagnosing the problem. Control of the run is directed to the AAS analyst. The analyst can, optionally, make a correction to this type of work order if he/she thinks this may resolve the problem. The diagnostic work order is placed together with the nominal work orders but it is put into a suspend mode. When the analyst is ready to run and monitor the diagnostic run, the analyst activates the work order and, at that time, can, optionally, advance the position of the work order in the queue. A diagnostic work order has halts in it at the end of scripts to allow the analyst to monitor the run more closely. At a halt point, the analyst resumes the run if he/she wishes it to continue. If the L1 product that is generated from this run is correct, i.e., the problem was resolved, the analyst can approve the product and allow the product to be transmitted to the ECS.

The second, a reprocessing work order, is generated by creating a modified version of the original work order, with any corrections that the analyst decides are needed to correct the problem. In this situation, the analyst would be sufficiently confident of the solution to the problem so that a diagnostic run would not be necessary. A reprocessing run goes through the system in the normal mode, controlled in the same way as a regular LPGS work order. However, any event messages are forwarded to the analyst screen. If the result is good, the L1 product is automatically transmitted to the ECS.

The third, a benchmark work order, is generated when the analyst suspects that there may be a system wide problem. This would involve running a known good image through the system to verify that the system is working correctly. If the benchmark run is not successful, this would indicate that there is a problem with the LPGS system, and the LPGS system would most likely have to be shut down until the problem is corrected.

10.3.2.3 Retrieve LPGS Data

DFD 3.0 shows this function (Figure 10–5). The Retrieve LPGS Data function allows the analyst, through the AAUI, to view any data files, database tables, and images associated with the anomalous work order in order to diagnose the problem.

10.3.2.4 Generate Reports

DFD 4.0, which has not been further decomposed, shows this function (Figure 10–2). AAS generates three reports: the Anomaly Report, the Problem Report Response, and the Anomaly History Report.

The Anomaly Report is generated when an anomaly is a scientific type of problem and therefore is transmitted to the DHF for further analysis. Also, when a production type problem cannot be resolved by the AAS, it is also included in an Anomaly Report. The report will contain information about the anomaly and also information needed to access the files associated with the anomalous work order.

The Problem Report Response is a report on any Problem Report that is received. If the associated anomaly was resolved, this report documents the solution and the location of the regenerated L1 product. If the anomaly was not resolved, this report explains why it was not resolved.

The Anomaly History Report is a formatted report of the Anomaly History Data Store that is maintained in the database. The analyst can specify a time range or other key information when requesting this report. Looking at past problems and how they were resolved helps the analyst in diagnosing current problems.

10.3.2.5 Transmit Anomalies

DFD 5.0, which has not been further decomposed, shows this function (see Figure 10–2). The Anomaly Report, containing preproduction anomalies that could not be resolved, is transmitted to the DHF and forwarded to the DAAC Manager. Before transmitting the Anomaly Report, this function saves any files that are needed in order to analyze the problem. The Problem Report Response is also transmitted to the DHF and forwarded to the DAAC Manager. Any L1 product that is regenerated in response to the Problem Report is saved.

10.3.3 AAS Design Structure

Most of AAS will be implemented through the use of COTS products, including ENVI, IDL, FrameMaker, and Oracle. The AAS structure chart, as shown in Figure 10–6, and its associated M-specs describe those remaining components that require customized software development. These components are mainly involved in managing the anomalies, i.e., keeping track of the anomalies in the Anomaly Status Table, setting up directories, generating work orders, etc. Since, the AAS design is driven by the analyst interface, the main control module, AMA_main, will be called primarily as a result of an analyst request. Following are the module specifications that are associated with the structure chart.

NAME: AMA_main

TITLE: Manage Anomalies

BODY: This is the main control module for managing anomalies. This module invokes the appropriate module depending on the requested activity.

NAME: AMA_recv_prob_rept

TITLE: Receive Problem Report

BODY: When the AAS analyst enters into the system a Problem Report that was received from the ECS, this module adds an entry for the problem into the anomaly status table. Parameters include items such as product request ID and type (external). PCS finds this

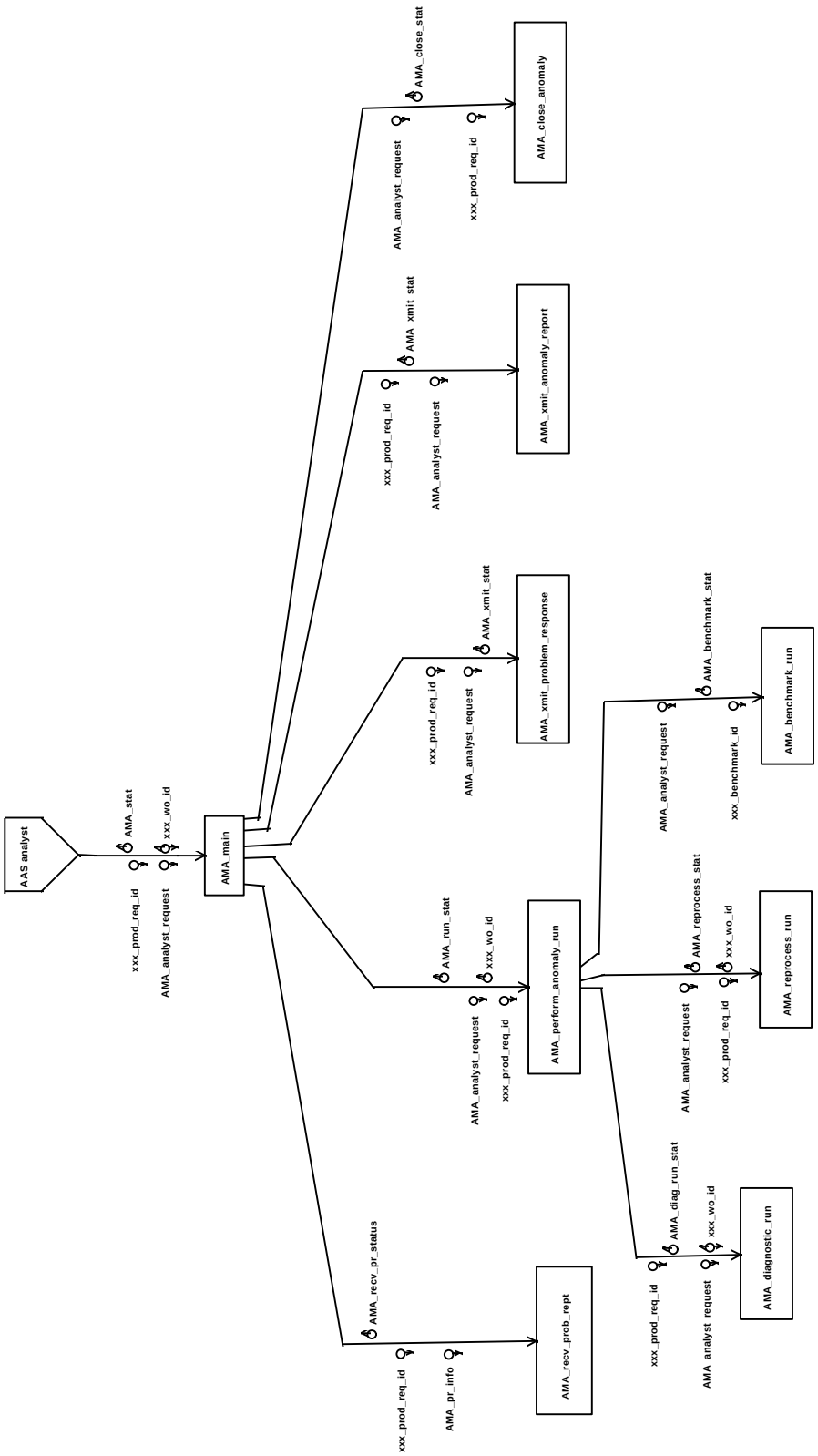

Figure 10–6. AAS Structure Chart

entry in the table and performs the appropriate action to obtain the L0 product associated with this Problem Report.

NAME: AMA_perform_anomaly_run

TITLE: Perform Anomaly Run

BODY: This module controls performing runs for the anomaly. If the analyst request is for setting up a new run, a directory will be created for the input, intermediate and output data for the run. The appropriate module is then called depending on the type of run (reprocessing, diagnostic, or benchmark).

NAME: AMA_diagnostic_run

TITLE: Perform Diagnostic Run

BODY: This module is called when the analyst, through the AAUI, enters a requested action involving a diagnostic run. Requested actions are as follows: set up work order, activate work order (i.e., remove from suspend mode), change the place of the work order in the queue, resume work order (after a halt), and approve L1 product.

If the request is to set up a work order, a work order is added to the database, and is placed in suspend mode. The input data files are then copied from the nominal work order directory to another directory. The anomaly status table is updated to indicate that a diagnostic work order has been set up. If the request is to activate, change position of, or resume a work order, the processing state of the work order is updated in the database.

NAME: AMA_reprocess_run

TITLE: Perform Reprocessing Run

BODY: This module is invoked when the analyst, through the AAUI, requests a reprocessing run. A reprocessing run is run in the normal mode. The product will be packaged and transmitted as usual if no problems are found. This module moves the input files into the work order input directory, sets up a reprocessing work order in the database, and updates the anomaly status table.

NAME: AMA_benchmark_run

TITLE: Perform Benchmark Run

BODY: This module will be invoked when the analyst requests a benchmark run through the AAUI. A benchmark run uses as input a known good L0 image product and shows whether there may be a systemwide problem This module moves the input benchmark data into the input work order directory. A benchmark work order is then set up in the database.

NAME: AMA_xmit_anom_report

TITLE: Transmit Report

BODY: This module transmits the Anomaly Report or the Problem Report Response to the DHF.

NAME: AMA_close_anomaly

TITLE: Close Out Anomaly

BODY: This module is invoked when an anomaly is ready to be closed out. This would be after an anomaly is forwarded to the DHF, or after an anomaly has been corrected. To close out the anomaly, the anomaly is marked as closed in the anomaly status table. Also, the Anomaly History Report, is updated to include information about the anomaly.